

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE  
 in its capacity as elected Office

Date of mailing (day/month/year) 15 February 2001 (15.02.01)	
International application No. PCT/GB00/02202	Applicant's or agent's file reference AA 1464 PCT
International filing date (day/month/year) 07 June 2000 (07.06.00)	Priority date (day/month/year) 15 June 1999 (15.06.99)
Applicant HAWKER, Pelham, Nigel	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
 10 January 2001 (10.01.01)

☐ in a notice effecting later election filed with the International Bureau on:  
 \_\_\_\_\_

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Olivia TEFY Telephone No.: (41-22) 338.83.38
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**Application No:** GB 9913732.5  
**Claims searched:** 1 to 9

**Examiner:** John Twin  
**Date of search:** 24 September 1999

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK Cl (Ed.Q): F1B (B2LA, BB140)  
Int Cl (Ed.6): F01N 3/28; F02D 21/08; F02M 25/07  
Other: Online: EPODOC, JAPIO, WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	DE 19853119 A (AVL List) - see eg WPI abstract accession no.99-339019	1,8
X	JP 8-338320 A (Hino Motors) - see eg WPI abstract accession no.97-104299; Patent Abstracts of Japan, vol.097004	1,2,4,8
X	JP 6-066208 A (Yanmar Diesel) - see eg Patent Abstracts of Japan, group M1621, vol.018314	1,2,4,8

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>AA 1464 PCT</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/GB 00/ 02202</b>	International filing date (day/month/year) <b>07/06/2000</b>	(Earliest) Priority Date (day/month/year) <b>15/06/1999</b>
Applicant  <b>JOHNSON MATTHEY PUBLIC LIMITED COMPANY et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

**1. Basis of the report**

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

1



None of the figures.

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
21 December 2000 (21.12.2000)

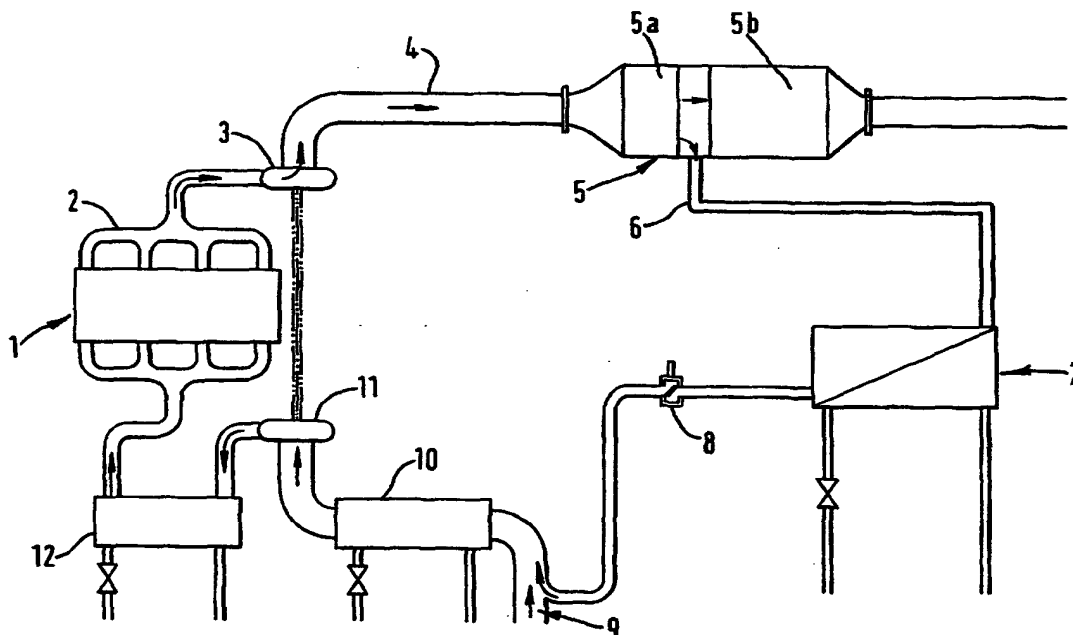
PCT

(10) International Publication Number  
**WO 00/77353 A3**

- (51) International Patent Classification: F02M 25/07, F01N 3/035, 3/023
- (21) International Application Number: PCT/GB00/02202
- (22) International Filing Date: 7 June 2000 (07.06.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 9913732.5 15 June 1999 (15.06.1999) GB
- (71) Applicant (for all designated States except US): JOHN-SON MATTHEY PUBLIC LIMITED COMPANY [GB/GB]; 2-4 Cockspur Street, Trafalgar Square, London SW1Y 5BG (GB).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): HAWKER, Pelham, Nigel [GB/GB]; The Dove House, Rectory Lane, Fowlmere, Royston SG8 7TJ (GB).
- (74) Agent: WISHART, Ian, Carmichael; Johnson Matthey Technology Centre, Blounts Court, Sonning Common, Reading RG4 9NH (GB).
- (81) Designated State (national): US.
- (84) Designated States (regional): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).
- Published:  
— With international search report.
- (88) Date of publication of the international search report: 31 May 2001

[Continued on next page]

(54) Title: IMPROVEMENTS IN EMISSIONS CONTROL



(57) Abstract: A diesel engine (1) has an exhaust system (4) and an oxidation catalyst (5a). Exhaust gas for recirculation is taken through an intake pipe (6) downstream of the catalyst, and preferably upstream of a filter (5b) for soot. The recirculated gases are passed through a cooler (7) upstream of the EGR valve (8). Good removal of soot and NO<sub>x</sub> is achieved even at low exhaust gas temperature.

WO 00/77353 A3

WO 00/77353 A3



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

Interr Application No  
PCT/GB 00/02202

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 F02M25/07 F01N3/035 F01N3/023		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 F02M F01N		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, PAJ		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 09307 A (JOHNSON MATTHEY PLC) 25 February 1999 (1999-02-25) page 4, line 8 - line 29; figure 1 abstract	1-3,8-10
A	DE 40 07 516 A (KLÖCKNER-HUMBOLDT-DEUTZ) 12 September 1991 (1991-09-12) abstract column 2, line 3 - line 65; figure 1	1,8,9
A	WO 95 27128 A (BROWN, LOWI, BENZ) 12 October 1995 (1995-10-12) abstract page 8, line 19 -page 10, line 9; figure 1	1,9
<input type="checkbox"/> Further documents are listed in the continuation of box C. <span style="margin-left: 100px;"><input checked="" type="checkbox"/> Patent family members are listed in annex.</span>		
* Special categories of cited documents : <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
Date of the actual completion of the international search  <div style="text-align: center; font-weight: bold;">11 September 2000</div>		Date of mailing of the international search report  <div style="text-align: center; font-weight: bold;">18/09/2000</div>
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer  <div style="text-align: center; font-weight: bold;">Van Zoest, A</div>

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter Application No

PCT/GB 00/02202

Patent document cited in search report	Publication dat	Patent family member(s)	Publication dat
WO 9909307 A	25-02-1999	AU 8738798 A EP 1003958 A	08-03-1999 31-05-2000
DE 4007516 A	12-09-1991	NONE	
WO 9527128 A	12-10-1995	AU 6507296 A	23-10-1996

## PATENT COOPERATION TREATY

ADDN

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

WISHART, Ian  
JOHNSON MATTHEY TECHNOLOGY CENTRE  
Blounts Court  
Sonning Common  
Reading RG4 9NH  
GRANDE BRETAGNE

RECEIVED

17 SEP 2001

PCT

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT  
(PCT Rule 71.1)

Date of mailing  
(day/month/year)

13.09.2001

Applicant's or agent's file reference  
AA 1464 PCT

## IMPORTANT NOTIFICATION

International application No.  
PCT/GB00/02202

International filing date (day/month/year)  
07/06/2000

Priority date (day/month/year)  
15/06/1999

Applicant

JOHNSON MATTHEY PUBLIC LIMITED COMPANY et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

## 4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/



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Authorized officer

Marra, E

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# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference AA 1464 PCT	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/02202	International filing date (day/month/year) 07/06/2000	Priority date (day/month/year) 15/06/1999
International Patent Classification (IPC) or national classification and IPC F02M25/07		
Applicant JOHNSON MATTHEY PUBLIC LIMITED COMPANY et al.		

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 4 sheets, including this cover sheet.
  - ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

- This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 10/01/2001	Date of completion of this report 13.09.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Christodoulou, T Telephone No. +49 89 2399 2721 

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02202

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, pages:

1,2,5,6	as originally filed	
3,3a,4	with telefax of	19/06/2001

### Claims, No.:

1-8	with telefax of	19/06/2001
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### Drawings, sheets:

1/1	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/02202

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	1-8
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-8
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-8
	No:	Claims	

2. Citations and explanations  
**see separate sheet**

## VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**V.**

1. The document **WO 99/09307** (D1) is regarded as being the closest prior art to the subject-matter of claims 1 and 8, and discloses a diesel engine and a process for the reduction of polluting emissions from diesel engine exhaust gases, with an oxidation catalyst (5a) and an exhaust gas recirculation system, wherein the EGR system (6, 7, 8) is mounted downstream of the oxidation catalyst (5a), so that the portion of exhaust gases recirculated has passed through the oxidation catalyst. The features in the characterising part of claims 1 and 8 of the present application are considered as involving an inventive step (Article 33(3) PCT), because arranging the particulate trap downstream of the EGR system intake is not rendered obvious by the prior art. The advantage of this arrangement is that no "wet" particulate matter contacts the EGR valve.
2. Claims 2-7 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

**VIII.**

1. Line 2 of claim 1 should read "catalyst (5a), a **particulate** trap (5b) ...";
2. In claim 5 the term "the filter" is undefined;
3. Line 5 of claim 8 should read "... of the point of taking **said portion** of the resulting gas ...".

incorporates a catalyst effective to convert NO to NO<sub>2</sub> under normal operating conditions,  
5 a trap for particulates mounted downstream of the catalyst and an exhaust gas recirculation  
system mounted downstream of the trap, and provided with cooling means to cool the  
portion of exhaust gas which is recirculated.

DE-A-4007516 describes a diesel engine including an exhaust system having an  
10 oxidation catalyst and a particulate trap located downstream thereof.

It is noted that the gases for exhaust gas recirculation in WO 99/09307 and  
DE-A-4007516 are taken downstream of the trap, thus benefitting from reduced particulate.

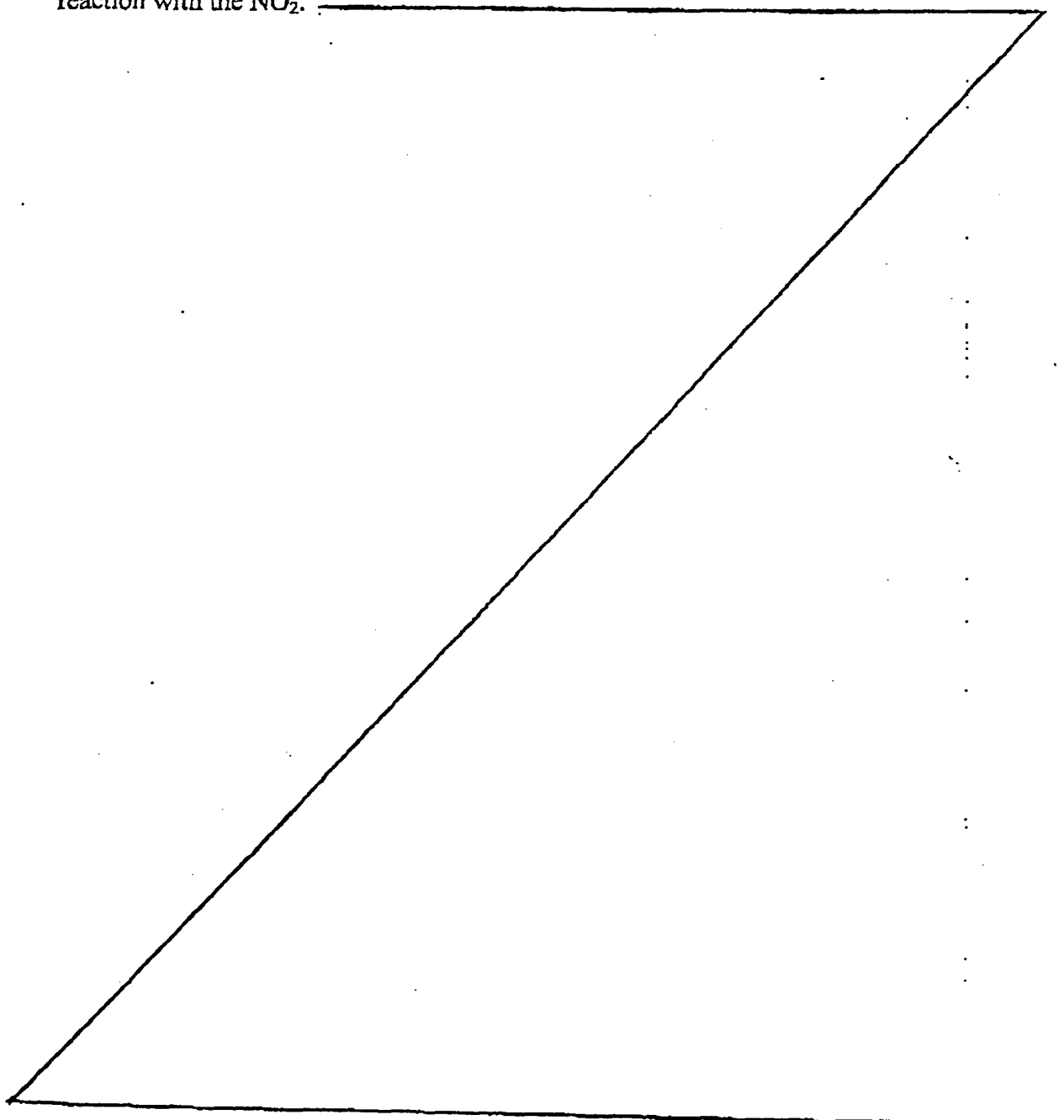
15 The present invention provides a modified diesel EGR and catalyst system,  
comprising a diesel engine provided with an exhaust system, which exhaust system  
comprises an oxidation catalyst and an exhaust gas recirculation system, characterised in that  
the exhaust gas recirculation system intake is mounted downstream of the oxidation catalyst,  
and upstream of a trap for particulates, such that the portion of exhaust gases recirculated  
20 has passed through the oxidation catalyst.

Preferably, the oxidation catalyst is effective to oxidise at least a portion of NO in  
the exhaust gases to NO<sub>2</sub>, under typical conditions for said engine. More preferably, the  
catalyst is a high loading platinum catalyst carried on a metal or ceramic flow-through  
25 honeycomb catalyst support. Such a support may have from 50 to 800 cells/sq.in, preferably  
about 400cps. The catalyst may have a loading from 10 to 150 gm Pt/cu ft of catalyst,  
preferably 75 to 100g/cu ft, optionally in association with one or more other platinum group  
metals and/or one or more base metal catalysts or promoters, such as Ce, V, W or Zr.

30 The present invention also provides a process for the reduction of polluting emissions  
from diesel engine exhaust gas including NO<sub>x</sub>, comprising passing the engine-out exhaust  
gas through an oxidation catalyst to generate NO<sub>2</sub> from NO in the gas, taking a portion of  
the resulting gas from the resulting gas stream and recycling said portion to the engine intake

3a

5 and trapping particulates in a filter mounted downstream of the point of taking the resulting gas and oxidising the particulates by reaction with at least some of the  $\text{NO}_2$  generated by the oxidation catalyst. Preferably, at least the majority of carbonaceous particles in the remaining gases are collected on a trap and continuously or semi-continuously oxidised by reaction with the  $\text{NO}_2$ .



The exhaust gas recirculation may be carried out using essentially well established technology, using valves in the exhaust system and a control system. It is believed that the present invention may be operated most effectively at a lower recirculation ratio (eg 5 to 30% by vol preferably 12 to 20% by vol) than is normal. Although engine intake vacuum may provide adequate EGR, it may be preferable to use pumping to provide a vacuum using a variable speed fan or pump operating under the control of the engine management unit.

Preferably, the EGR valve is mounted downstream, in the recirculation loop, of the cooler, whereby a proportion of the particulate is removed from the gases in the cooler. Since the recirculated gases are enriched with NO<sub>2</sub>, it is possible, depending upon gas temperatures, flow rates and residence times, for a proportion of particulates to be wholly or partially combusted within the cooler or "during flight".

It is to be realised that since only a portion of the exhaust gases is recycled, the system and process of the invention desirably include a particulate trap downstream of the EGR loop, such that all the gases fed to the exhaust outlet pipe are filtered. A preferred trap is an extruded ceramic, e.g. cordierite, wall flow filter. Other filters including metal mesh or metal or ceramic foams, may also be considered. Filters as such are not essential, if the system provides sufficient residence time for particulate to be oxidised by reaction with NO<sub>2</sub> in flight, possibly adhering to the front face or within the cells of catalytic components or variants on these.

The present invention is believed to offer, in its preferred embodiments, certain unexpected advantages. The invention, because it does not depend upon a NO<sub>x</sub> reduction catalyst reaching light-off temperature, is effective to reduce NO<sub>x</sub> at all engine operating temperatures. This has increasing importance as diesel engines are designed to give increasing efficiency and exhaust gas temperatures fall. Additionally, traditional EGR systems suffer from wear and other degradation both of the EGR valves which are used to extract the recirculating portion of the exhaust gases, and on engine or exhaust components themselves. Such degradation may lead to expensive rebuilds and engine downtime, and a system that offers the potential for savings in this area has considerable economic value.

**CLAIMS**

5

1. A diesel engine (1) provided with an exhaust system (4) comprising an oxidation catalyst (5a), a particulated trap (5b) and an exhaust gas recirculation system ("EGR"), wherein the EGR system intake (6) is mounted downstream of the oxidation catalyst, so that the portion of recirculated exhaust gas passes through the oxidation catalyst, characterised in that the particulate trap is downstream of the EGR system intake.

10

2. A system according to claim 1, so arranged that all of the remainder of the un-recirculated exhaust gas passes through the particulate trap.

15

3. A system according to claim 1, wherein the particulate trap is mounted in the EGR system.

4. A system according to claim 1, 2 or 3, wherein the particulate trap is effective to trap at least 50% by wt of particulates in the exhaust gas.

20

5. A system according to claim 4, wherein the particulate trap comprises by-pass means, the arrangement being such that blocking of the filter does not cause excessive back-pressure in the exhaust system.

25

6. A system according to any preceding claim, wherein the recirculation ratio of the EGR system may be varied from 5 to 30% by volume.

7. A system according to any preceding claim, comprising a cooler (7) for the recirculated gases, said cooler being mounted upstream of an EGR valve (8).

30

8. A process for the reduction of polluting emissions from diesel engine exhaust gas including NO<sub>x</sub>, comprising passing the engine-out exhaust gas through an oxidation catalyst to generate NO<sub>2</sub> from NO in the gas, taking a portion of the resulting gas from the resulting



gas stream and recycling said portion to the engine intake and trapping particulates in a filter  
5 mounted downstream of the point of taking the resulting gas and oxidising the particulates  
by reaction with at least some of the  $\text{NO}_2$  generated by the oxidation catalyst.